On the Absorption of λ 5460·97 A. by Luminous Mercury Vapour.

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[Plate 1.]

1. *Introduction.*

Numerous investigators who have studied the structure of the mercury green line λ 5460·97 A. have found that it consists of a wide central unresolved band, flanked on either side by three or more clearly resolved components that are usually designated as satellites. Janicki[*] has shown, however, and so has Nagaoka,[†] that the central portion of the line can be resolved into well defined components when a Lummer plate of high resolving power is used by itself, or is crossed with another of the same kind, or with a high grade *échelon* spectrograph. From such investigations it would appear to be definitely settled that the line is produced by twelve separable and distinct wave-lengths. These components, as measured by Nagaoka, are shown in their relative positions, and with approximately their relative intensities, in fig. 1. The values of their relative wave-lengths, as measured by Janicki and Nagaoka, are given in Table I.

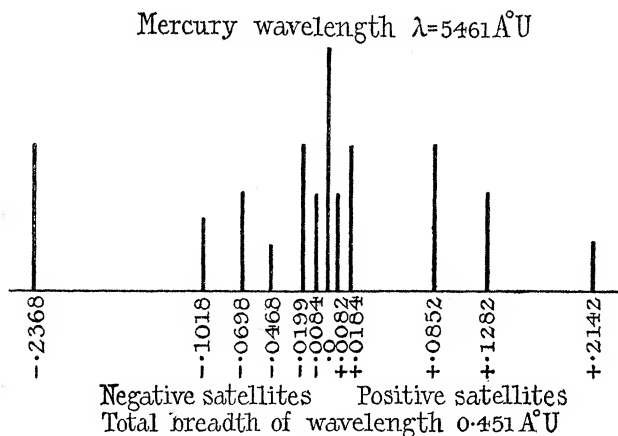In their investigations on the structure of the line λ 5460·97 A., Janicki,[‡]

Mercury wavelength λ=5461 Å U

-·2368 -·1018 -·0698 -·0468 -·0199 -·0084 -·0082 -·0184 +·0852 +·1282 +·2142

Negative satellites   Positive satellites
Total breadth of wavelength 0·451 Å U

Fig. 1.

[*] Janicki, 'Ann. der Phys.,' vol. 33, p. 438 (1912).

[†] Nagaoka, 'Proc. Tokyo Math. Soc.,' 2nd Ser., vol. 8, No. 8, p. 229, October, 1915.

[‡] Janicki, 'Ann. der Phys.,' vol. 19, p. 35 (1906).

Table I.—Structure of Line λ 5460·97 A.

Component.	Δλ (Janicki).	Δλ (Nagaoka).	Δλ (Mean).
−6	−0·236 A.	−0·2368 A.	−0·2364 A.
−5	−0·102 A.	−0·1018 A.	−0·1019 A.
−4	−0·068 A.	−0·0698 A.	−0·0689 A.
−3	−0·048 A.	−0·0468 A.	−0·0474 A.
−2	−0·022 A.	−0·0199 A.	−0·021 A.
−1	−0·009 A.	−0·0084 A.	−0·0087 A.
M	0·000 A.	0·0000 A.	0·0000 A.
1	0·009 A.	0·0082 A.	0·0086 A.
2	0·018 A.	0·0184 A.	0·0182 A.
3	0·084 A.	0·0852 A.	0·0846 A.
4	0·1281 A.	0·1282 A.	0·1281 A.
5	0·2141 A.	0·2142 A.	0·2141 A.

Prince Galitzin and Wilip,* Stansfield† and one of the writers found that, when an Heraeus quartz mercury arc lamp was used as the source of light (and also when other forms of lamps were used as well), the structure of the line underwent a profound modification when the radiation was produced by the passage of very heavy electric currents in place of weak ones. Janicki observed, in place of the original line and its satellites, a peculiar system of five equidistant bands, the original components of the line being apparently lost in a continuous spectrum.

Prince Galitzin and Wilip suggested that the effect was probably due to a reversal of some of the constituents of the line or to some property of the resolving apparatus, and Stansfield rather favoured the view that the bands were due to secondary spectra produced by the *échelon* that he used. The view taken by one of us was that the phenomenon had the appearance of a reversal of the main component due to absorption, together with a widening and intensification of the satellites arising from an increase in the temperature and pressure of the mercury vapour in the lamp.

This view was in keeping with some observations made by Kuch and Retschinsky‡ on the illumination from two mercury lamps, one of which was placed behind the other so that the light from the first had to traverse the vapour in the second. They found that the radiation from the combination of lamps with this arrangement was less than the sum of the radiations from each separately. Similarly, from direct photometric measurements, it was shown by Pflüger§ and by Grebe‖ that radiation of the wave-length λ 5460·97 A. had its intensity diminished by being passed through mercury vapour in a luminous condition.

* Prince Galitzin and Wilip, 'Bull. de l'Acad. Sc. de St. Pétersbourg,' 1907, p. 159.
† Stansfield, 'Phil. Mag.,' 1909.
‡ Kuch and Retschinsky, 'Ann. der Phys.,' vol. 22, p. 882 (1907).
§ Pflüger, 'Ann. der Phys.,' vol. 26, p. 789 (1908).
‖ Grebe, 'Ann. der Phys.,' vol. 36, p. 834 (1911).

By the use of an interferometer of the Jamin type, Koch and Friedrich[*] showed that anomalous dispersion, too, could be obtained at λ 5460·97 A. with mercury vapour feebly luminous, but not with the vapour in the ordinary non-luminous condition.

Further, Starke and Herweg,[†] in reporting in 1913 on some experiments made by them preliminary to studying magnetic rotation and the inverse Zeeman effect with mercury vapour, state that they found, when the light from a strongly excited mercury lamp was passed through a second feebly excited one, they could, when a pair of nicols was used to suitably modify the intensity of the light emitted by the first lamp, obtain a reversal of the main component of the line λ 5460·97 A. They also state, without giving the wave-lengths involved, that they observed reversals of the satellites of the main line.

From this investigation it would appear that, in mercury vapour in the luminous condition, atoms of mercury exist in states suitable for the absorption of a number of those wave-lengths of light which in the aggregate produce the spectral line λ 5460·97 A.

In a paper published by Metcalfe and Venkatesachar,[‡] in November of last year, there was described a series of interesting experiments on the absorption of the wave-length λ 5460·97 A. by mercury vapour rendered luminous by the passage of electric currents of varying intensities. In these experiments the observations were made with a Fabry and Perot interferometer, a low-power *échelon* spectrograph, and a concave grating having a radius of 10 feet and a ruling of 45,000 lines.

With the Fabry and Perot interferometer a reversal was obtained not only of the main component of the green line, but also apparently of the satellite λ + 0·09 A. (No. + 3, Table I). The authors cited also reported that, with the concave grating, the reversal of the green line on a continuous spectrum used as a background was obtained with striking clearness.

As Aston[§] has shown that mercury consists of some six isotopes with atomic weights 197–200, 202, 204, it would follow that, in the spectrum of each of these isotopes, there should be a wave-length approximately equal to λ 5460·97 A. Moreover, if the green line in the spectrum of one of the isotopes of mercury consists of a main component and one or more satellites, one should expect to find a similar structure for the green line in the spectrum of each of the other isotopes. It is presumable also that in

* Koch and Friedrich, ' Phys. Zeit.,' December 21, p. 1193 (1911).

† Starke and Herweg, ' Phys. Zeit.,' January 1, p. 1 (1913).

‡ Metcalfe and Venkatesachar, ' Roy. Soc. Proc.,' A, vol. 100, p. 149 (November, 1921).

§ Aston, ' Isotopes ' (Edwin Arnold and Co.), 1921, p. 72.

ordinary mercury vapour we have present atoms of each of the different isotopes of the element.   A question naturally arises, then, as to the identity of the wave-lengths that constitute the green line as ordinarily observed. Do all of the wave-lengths shown in fig. 1 arise from atoms of one only of the isotopes of mercury, or do some of these wave-lengths originate in the atoms of different isotopes of mercury?   Another question that arises is— should we expect the satellites of a main line to be absorbed to any appreciable extent when the main line itself is absorbed by luminous mercury vapour.

If some of the components shown in fig. 1 originate in the atoms of different isotopes of mercury, then, on the basis of the results obtained by the investigators cited above, one should expect to find that on passing radiation of the wave-length $\lambda\,5460 \cdot 97$ A. through luminous mercury vapour reversals would be obtained, at least in the case of those wave-lengths which represent the main constituent in the line group of wave-lengths associated with each isotope.

For the purpose of investigating this matter further than has been done, a series of experiments was made by the writers at intervals as opportunity offered during the past few months, and as a result it has been found that only in the case of the main component, designated 0 in fig. 1, and of satellites Nos. $+1$ and -1, Table I, was complete absorption obtained by mercury vapour rendered luminous by the passage through it of electric currents.   No reversals were obtained with any of the so-called satellites of the green line other than those mentioned.   In particular, no appreciable absorption was observed in any of our experiments of satellite No. $+3$, $\Delta\lambda = +0 \cdot 085$ A.

2. *Apparatus.*

In the experiments several different forms of mercury vacuum arc lamps were used, but one that was found specially useful is shown in fig. 2.
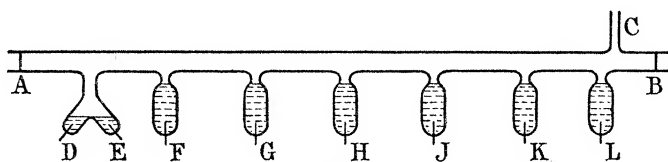

FIG. 2.

In operating this lamp, the current was drawn from the 110 D.C. mains. When the terminals D and E were used, the arc was easily started by giving the lamp a slight shake, and when other terminals were used, the lamp was generally started by heating the mercury in the terminal recesses with a

bunsen burner and then passing a weak discharge from a small induction coil through the vapourised mercury.

In studying the constitution of the green line λ 5460·97 A., two Lummer plates and an *échelon* spectrograph of thirty plates were used, both already described in other communications.* In all experiments the radiation constituting the green line was isolated by means of one of the filters made by the Adam Hilger Company for the purpose.

3. *Emission Experiments.*

In the first set of experiments the constitution of the green line was investigated by analysing the radiation issuing laterally from a Cooper Hewitt mercury arc lamp, operated on currents of between 3 and 4 ampères.

The resolution obtained with the *échelon* spectrograph is shown in *b*, fig. 3, and with the Lummer plate in *b*, fig. 4, Plate 1. The constitution of the line, as revealed by the *échelon* and the Lummer plates, was a central unresolved band, flanked on one side by the satellites Nos. −6, −5, and −4, and on the other side by the satellites No. +3, +4.

From reproduction *b*, fig. 4, it will be seen that satellite No. −6 of one order in the Lummer plate diffraction pattern came between the unresolved band and satellite No. +3 of the next lower order. The correctness of the identification of this satellite was established by obtaining the fringe pattern with the *échelon* crossed with a Lummer plate. Such a fringe pattern is shown in fig. 5, Plate 1. In this pattern, satellite No. −6 is indicated by the letters *a, a, a, a.*

When the *échelon* was used crossed with a Lummer plate, it will be seen that satellite No. +5 (see *d, d, d, d,* fig. 5) was also brought into evidence. On several occasions in the course of our observations satellite No. −3 was seen, but it was always weak. It was faintly recorded between satellite No. −4, and the unresolved portion of the line on the negative from which *b* in fig. 4 was obtained. On account of its weak intensity, its distinctness was lost in the process of reproduction, and it only appears in the reproduction as a blurred strip.

As a result of our emission experiments we were able to confirm the existence of the satellites Nos. +3, +4, +5, and −3, −4, −5, −6. The main constituent and the satellites Nos. +1, +2 and Nos. −1, −2, we were not able to resolve directly with the optical equipment at our disposal. It will be seen later, however, that we were able to demonstrate quite definitely the existence of the satellites Nos. +2 and −2.

* McLennan, 'Roy. Soc. Proc.,' A, vol. 87, p. 269 (1912); McLennan and McLeod, Roy. Soc. Proc.,' A, vol. 90, p. 243 (1914).

4. *Absorption Experiments.*

In our first absorption experiments lamps similar to that shown in fig. 2 were used and observations were made by studying the radiation issuing from the ends of the lamp A and B.   The lamp it may be stated was continuously exhausted during the experiments by a Gaede mercury pump.   In preliminary experiments it was found that when a strong arc was established between D and E, D and F, D and G, F and G, or F and H, for example, the mercury vapour was distilled over from the arc towards B the colder portion of the tube.   This distilled vapour was generally luminous and of a salmon or pinkish colour.   Under these circumstances end-on observations at B showed that in the portion of the line $\lambda 5460 \cdot 97$ A. that we found unresolved in our emission experiment described above there always appeared a narrow dark reversal line.   This reversal produced by the pinkish coloured luminous vapour was always distinct but it was not what could be called a strong reversal.

If, however, with a strong arc established between D and H, for example, we passed a discharge from a $\frac{1}{4}$ kilowatt Clapp Eastham 15,000 volt transformer operated on a current of about 1 ampère through the vapour between J and K or J and L it was found that reversal became much more marked.   When the mercury in the recesses J and K or L, and the tube between these points as well, was strongly heated with the flame of a Bunsen burner, it was found possible with a certain application of heat, to obtain a vapour between J and K in such a condition of pressure or temperature, or probably both, that the appearance of the transformer discharge suddenly underwent a definite and very marked change.   Under conditions of room temperature the discharge from the transformer was generally of a whitish appearance, but when the vapour reached the state mentioned, it suddenly took on a blue-greenish appearance.   Under these circumstances the absorption was very marked, more extensive, and very clearly defined.

Photographs taken of the *échelon* and the Lummer plate patterns under these circumstances are reproduced in *a*, fig. 3, and in *a*, fig. 4, Plate 1.   From these it will be seen that the central portion of the unresolved band in *b*, fig. 3, and *b*, fig. 4, was absorbed.   This result was similar to what was observed by Metcalfe and Venkatesacher.

Various attempts were made by increasing the discharge from the transformer and by making alterations in the density of the vapour through which the discharge passed to widen out the absorption band, but it was found that while it could be obtained with widths extending all the way from a thin clearly defined line to the width shown in reproductions *a*, figs. 3 and 4, it apparently reached a definite width beyond which it could not be extended.

This suggested that what appeared in *a* of figs. 3 and 4 as two unabsorbed edges of the wide central band shown in *b*, figs. 3 and 4, was really the
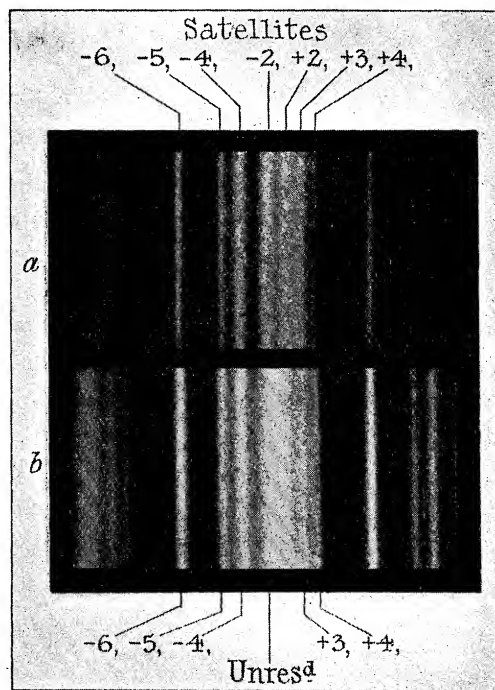

Fig. 3.

fringe pattern of the two satellites Nos. +2 and −2 found by Nagaoka and Janicki. To test this idea we carefully measured up our plates and it was found by taking satellite No. +4 as the base of our measurements that the unabsorbed edges gave for Δλ their reduced separation from the main component (as given by Nagaoka and Janicki) +0·019 A. and −0·020 A. As the averages of Nagaoka and Janicki's measurements of Δλ for satellites Nos. +2 and −2 were respectively +0·0182 and −0·021 we have concluded that what appeared as unabsorbed edges of the main line was in reality the two satellites Nos. +2 and −2.

It would appear, therefore, from our experiments that under the maximum absorption conditions which obtained in our experiments the absorption of the main line and of the satellites Nos. +1 and −1 was complete.

Our experiments, therefore, showed that, with the conditions used by us, complete absorption was obtained of the main line and of the satellites Nos. +1 and −1, but no trace of reversals with any of the satellites Nos. +2 +3, +4, +5 or −2, −3, −4, −5 and −6. Plate 1, fig. 5, brings out the fact that when the main component and the satellites Nos. +1 and −1 were

completely absorbed the satellite No. +5 was not absorbed.   In this figure, *c* and *b*, *i.e.*, satellites Nos. +2 and −2, are shown quite distinctly with the components 0 and Nos. +1 and −1 absorbed.   The figure also shows that under these conditions satellite No. 5, *i.e.*, *d, d, d, d,* did not show reversal, neither was it absorbed.

5.   *Absorption of the Zeeman Components of the Green Line.*

From a number of investigations it is known that when a mercury arc is established in a weak magnetic field the radiation constituting the green line emitted at right angles to the field is magnetically resolvable into three components.   In high magnetic fields, however, it can be broken up into nine equally spaced components, the spacing being equal to one quarter of the separation between the outer members of a normal Zeeman triplet.   Of these nine components those constituting the central triplets are polarised in a plane perpendicular to the lines of force, while those constituting the two outer triplets are polarised in a plane parallel to the magnetic field.

In our experiments on the absorption of the magnetic components of the green line, the arrangement of the lamp used is shown in *a* and *b* of fig. 6 It consisted of the branches FG and EK.   The one branch FG, shown
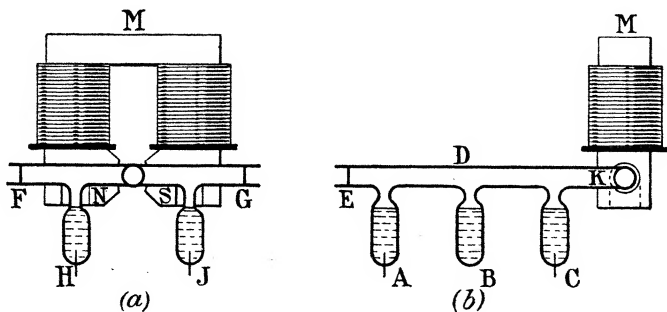

Fig. 6.

in *a*, fig. 6, was inserted within the pole pieces of an electromagnet, so as to lie along the lines of force, and the other was attached centrally to it and at right angles, as shown in *b*, fig. 6.   The arc was established between the terminals H and J, and the light which was studied was that which issued from the arc and passed through the branch KE.   On issuing from KE the light was passed through a collimator, and into the Lummer plate in the usual way.   On emerging from the Lummer plate, the light was passed through a Wollaston double-image prism and afterwards allowed to fall upon the lens of a camera.   With this arrangement, the image in the focal plane of the camera consisted of two fringe patterns which overlapped over a portion of
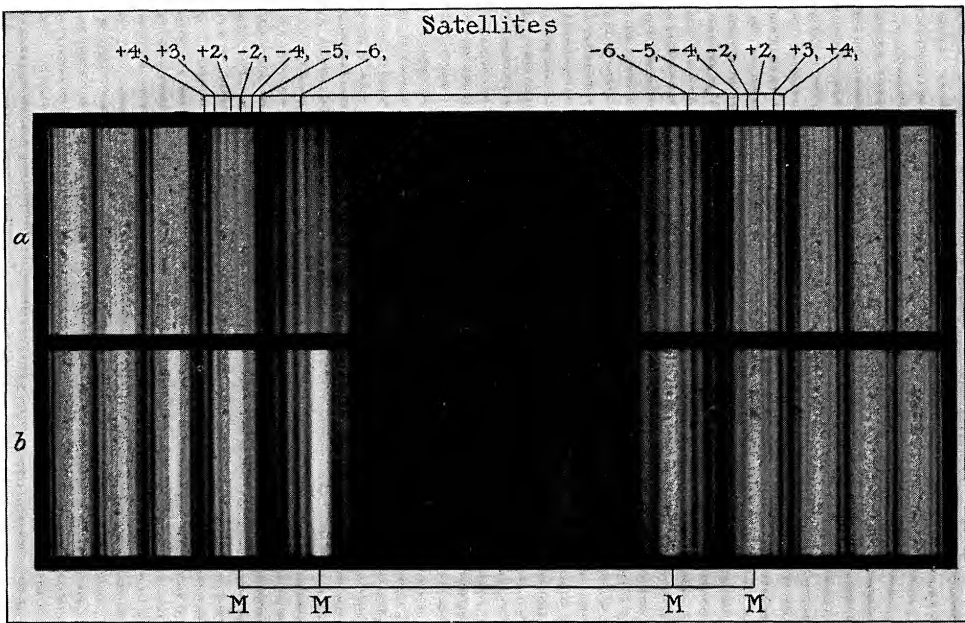
Satellites

+4, +3, +2, -2, -4, -5, -6,   -6, -5, -4, -2, +2, +3, +4,

a

b

M   M   M   M

Fig. 4.

d d d d   *c b   c b   b c   b c*   *d d d d*

a   a   a   a

a = Satellite -6
b =   " -2
c =   " $+2$
d =   " $+5$
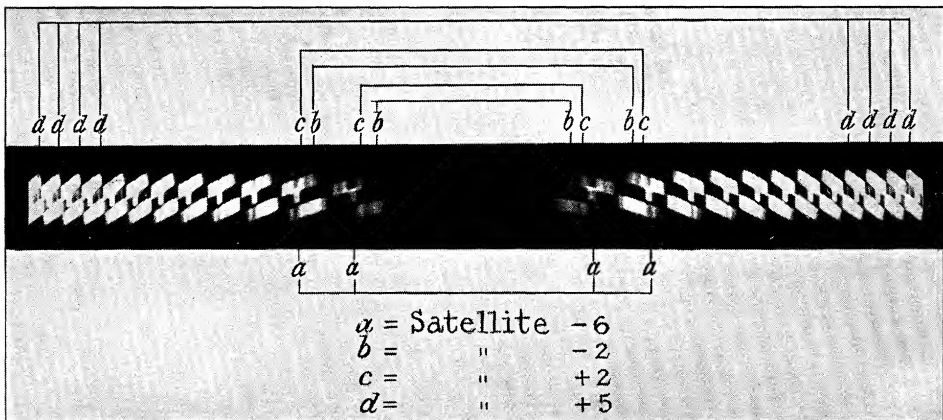
Fig. 5.

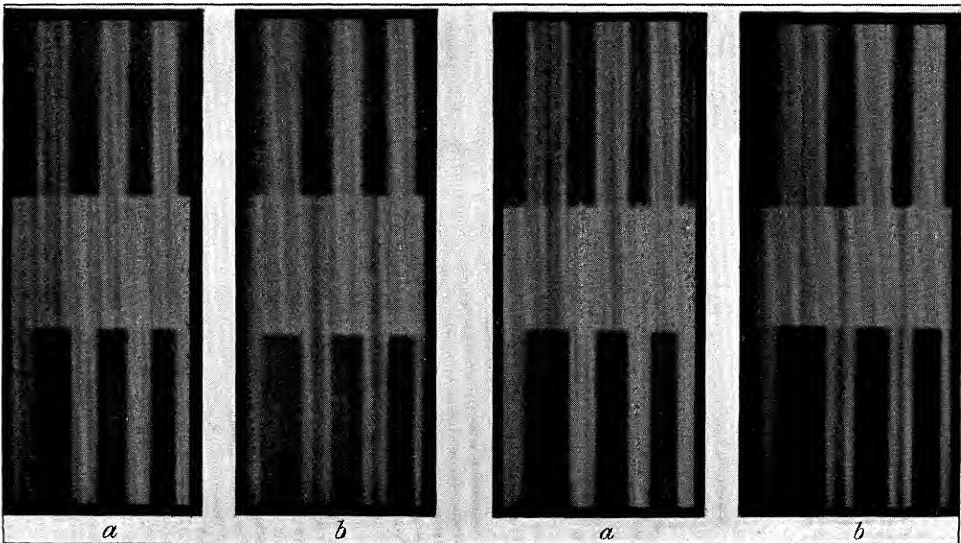*a*   *b*   *a*   *b*

Fig. 7.   Fig. 8.

their length. Care was taken to give the Wollaston prism such an orientation that, with no magnetic field on, the fringes in the upper pattern were directly in line with those in the lower. The prism was also arranged so that the light forming the upper pattern was polarised in a plane parallel to the lines of force, and that forming the lower pattern polarised in a plane perpendicular to the field.

In the first experiment magnetic fields were used sufficiently high to resolve the green line into a Zeeman nonet. The method of coincidence was applied, and it consisted in so choosing the magnetic field that the outer triplet on the left-hand side of one order in the upper fringe pattern coincided with the outer triplet on the right-hand side of the next higher order of the same pattern. A reproduction of a photograph is shown in *a*, fig. 7, Plate 1. It will be seen from the reproduction how accurately coincidence can be obtained. The light forming the fringes in the upper pattern was, as already stated, all polarised in a plane parallel to the lines of force, while that forming the fringes in the lower pattern was all polarised in a plane perpendicular to the field. The undisplaced component of the nonet was therefore the central fringe in each of the triplets shown in the lower pattern. With this method of coincidence, it is easy to see that the separation $\Delta\lambda$ of each of the outer members of the triplets in the lower pattern relative to the undisplaced member was equal to $1/6 \, \Delta\lambda_m$, where the value of $\Delta\lambda_m$ is given in the following table of data regarding the Lummer plate used to effect the resolution :—

Table II.

Data for Lummer plate.	Refractive indices.	
	λ (A).	$\mu.$
$d = 0 \cdot 448$ cm.	6563 ·045	1 ·50746
$\lambda = 5461 \times 10^{-8}$ cm.	5896 ·155	1 ·50990
$\mu = 1 \cdot 5121$	5890 ·186	
$d\mu/d\lambda = -530.$	4861 ·49	1 ·51560
$\Delta\lambda_m = 0 \cdot 2984$ A.	4308 ·08	1 ·52025

Since $\Delta\lambda_m$ was equal to 0·2984 A., it follows that the separation of the outer components of the triplets in the lower pattern from the central component was 0·0497 A.

In the second experiment exactly the same method was followed as that just described, except that the branch of the lamp EK was kept warm with a bunsen burner, and the vapour in it was traversed by the discharge from the small transformer already described. The fringe pattern obtained in this case is that shown in *b*, fig. 7, Plate 1. There it will be seen the light forming the central undisplaced component was completely absorbed by the luminous vapour in the branch EK, while the light forming the other eight magnetic components of the line suffered no appreciable absorption.

In another set of experiments the magnetic field was so chosen that the two outer members of the outer triplet on the left-hand side of one order in the upper pattern coincided with the two outer members of the outer triplet on the right-hand side of the next higher order of the same pattern. With this arrangement, the fringe system in the upper pattern consisted of a set of quartets, while that in the lower pattern consisted of a set of triplets. Reproductions of the photographs of the fringe systems obtained without and with the discharge from the transformer passing through the vapour in the branch FG, are shown in *a* and *b* respectively in fig. 8, Plate 1. There, again, it will be seen that the obliteration of the central undisplaced component was complete. In this case, also, no evidence was obtained of any appreciable absorption by the luminous vapour in EK of the light forming the other eight magnetic components of the line. The separation $\Delta\lambda$ of each of the outer members of the triplets in the lower pattern relative to the undisplaced member was in this case $1/7 \Delta\lambda_m$, *i.e.*, 0·0426 A.

In another set of experiments the magnetic field was so chosen that coincidence of the first class obtained. In this case the fringe system in the upper pattern consisted of a set of quintets, while that in the lower pattern again consisted of a set of triplets. Here again it was found that the central undisplaced component could be completely absorbed without the other eight magnetic components showing any appreciable absorption.

Finally, a magnetic field was used that was just sufficient to resolve the green line into a nonet. In this case there was no coinciding of the fringes, and both the upper and the lower patterns consisted of a set of very close triplets. Here also the central undisplaced component was completely absorbed without the other eight magnetic components showing any appreciable absorption. With this arrangement it was estimated that the separation of the outer components of the triplets in the lower pattern relative to the central undisplaced component was only slightly above 0·02 A.

With the evidence furnished by these experiments on the complete absorption of the central magnetic components of the line λ 5460·97 A. by luminous mercury vapour, it seems clear that we were justified in concluding that the fringes designated by $+2$ and -2 in *a* (fig. 3) and *a* (fig. 4, Plate 1) represented satellites Nos. $+2$ and -2, and not the unabsorbed edges of a broad and central main component of the line.

In this connection it may be pointed out that it follows from this conclusion that absorption by luminous mercury vapour of the light constituting the green line affords a means of easily and clearly demonstrating the existence of the satellites of the green line with displacements $\Delta\lambda = +0·0182$ A. and $\Delta\lambda = -0·021$ A.

It is of interest to note in passing that, in the absorption of the central magnetic component of the green line by the luminous vapour in FG, we have an example of plane polarised light being absorbed by atoms in a condition where they are capable of emitting only unpolarised light.

6. *Isotopes of Mercury.*

From what has gone before, it follows that, when light constituting the ordinary green line of mercury is passed through moderately luminous mercury vapour, the components of the line designated by zero and the two components separated from it by $\Delta\lambda = -0·087$ A. and $+0·0086$ A. can be completely absorbed.

In seeking for an explanation of this exceptional absorption by luminous vapour of these components, and the lack of any marked absorption in the case of the other components, one is reminded of the fact that mercury, as we ordinarily use it, consists very probably of five, and possibly of six, isotopes, with atomic weights 197–200, 202, 204.

It may be that the three components referred to originate in different isotopes of mercury. If this should be so, one would naturally associate the component zero with isotope 200 and the components $\Delta\lambda = -0·0087$ A. and $\Delta\lambda = +0·0086$ A. with the isotopes 202 and 198 respectively.

According to the Bohr theory, we have for two isotopes of an element the frequency relation

$$\frac{\nu_1}{\nu_2} = \frac{M_1(M_2+m)}{M_2(M_1+m)}, \quad i.e. \quad \frac{\lambda_2}{\lambda_1} = \frac{M_1(M_2+m)}{M_2(M_1+m)},$$

where M_1 and M_2 are the masses of the atoms of the respective isotopes and m is the mass of an electron.

i.e.
$$\frac{\Delta\lambda}{\lambda_1} = \frac{m(M_1-M_2)}{M_2(M_1+m)}.$$

Applying this to the case of isotopes 200 and 202 we have

$$\frac{\Delta\lambda}{\lambda_1} = \frac{-0·0005 \times 2}{202\,(200+0·0005)} = \frac{-0·001}{202 \times 200·0005} = -\frac{1}{40400101},$$

or
$$\Delta\lambda = -\frac{1}{40400101} \times 5460·97 \text{ A.} = 0·000135 \text{ A.}$$

In a similar way the separations $\Delta\lambda$ corresponding to all the other isotopes can be calculated. The results are given in Table III :—

Table III.

Isotope.	$\Delta\lambda$.	$\Delta\lambda \times 80$.
204	$-0\cdot000268 \times 10^{-8}$ cm.	$-0\cdot02144 \times 10^{-8}$ cm.
202	$-0\cdot000135$	$-0\cdot01080$
200	$0\cdot00000$	$0\cdot00000$
199	$+0\cdot0000685$	$+0\cdot00548$
198	$+0\cdot000138$	$+0\cdot01104$
197	$+0\cdot000279$	$+0\cdot02032$

From the above results it is seen that the maximum separation of the wavelengths at or near 5460·97 A. arising from all the isotopes of mercury is, on the Bohr theory, approximately $0\cdot000547 \times 10^{-8}$ cm., *i.e.*, it is about 1/15 of the separation of either of the satellites Nos. $+1$ and -1 from the zero central component.

On the Bohr theory, then, none of the eleven satellites of the green line can be considered as originating in any of the isotopes of mercury with atomic weights 197, 198, 199, 202, and 204.

In some experiments, however, that we have recently made with lithium we have found that the red line of lithium consists of two doublets with a separation between three and four times that calculated on the basis of Bohr's theory for isotopes of atomic weight 6 and 7. From this result and from the results obtained by Merton[*] and by Aronberg[†] in studying the spectral displacements for isotopes of lead, we have been led to put forward the view that the observable spectral displacements for isotopes should be given by the atomic number times their displacements calculated on the Bohr theory. To test this view, the displacements calculated for the isotopes of mercury on the Bohr theory have been multiplied by 80, the atomic number of mercury, and the results are given in column 3 of Table III.

Table IV.

Isotope.	Isotope displacement × atomic number.	Satellite.	Satellite separation.
204	$-0\cdot02144 \times 10^{-8}$ cm.	No. (-2)	$-0\cdot210 \times 10^{-8}$ cm.
202	$-0\cdot0108$	No. (-1)	$-0\cdot0087$
200	0	M	0
199	$0\cdot00548$	—	—
198	$0\cdot01104$	No. ($+1$)	$0\cdot0086$
197	$0\cdot02032$	No. ($+2$)	$0\cdot019$

These results are also given in Table IV, together with the separations of satellites Nos. ± 1 and ± 2, as found by Janicki and Nagaoka.

From this Table it will be seen that the calculated displacements for isotopes 204, 202, 198, and 197 are in approximate agreement with the

  * 'Merton, 'Roy. Soc. Proc.,' A, vol. 96, p. 388 (1920).

  † Aronberg, 'Proc. Nat. Acad. Sc.,' vol. 3, p. 710 (1917); and 'Astrophys. Journ.,' vol. 47, p. 96 (1918).

displacements corresponding to satellites Nos. −2, −1, and Nos. +1, +2. No satellite of the green line, however, has been identified as yet with the displacement calculated for an isotope of atomic weight 199, and this is rather interesting, for while Aston has found that there are isotopes of mercury with atomic weights between 197 and 200, he has not as yet been able to assert definitely that one exists with atomic weight 199.

Too great emphasis, however, should not be placed upon the view we have put forward tentatively that the spectral displacements for different isotopes can be determined by multiplying by the atomic number the displacements calculated on the Bohr theory.

For even if this view should turn out to be correct, and it might be used to explain the absorption by luminous mercury vapour of the main component and of the components Nos. +1 and −1 of the green line, it would leave unexplained the non-absorption by luminous mercury vapour of the components of the green line Nos. +2 and −2.

7. *Summary of Results.*

1. It has been shown that when the radiation constituting the green line of mercury is passed through moderately luminous mercury vapour, the main component and the components No. +1, $\Delta\lambda = 0·0086$ A., and No. −1, $\Delta\lambda = -0·0087$ A., can be strongly absorbed.

2. No marked absorption by luminous mercury vapour was observed in the case of the other nine components of the green line.

3. Of the nine members constituting the magnetically resolved green line, it was found that the central undisplaced member was the only one that could be markedly absorbed by luminous vapour.

4. It has been shown that absorption by luminous mercury vapour of the light constituting the green line in the spectrum of mercury, affords a means of clearly and easily demonstrating the existence of the components of the line with separations $\Delta\lambda = + 0·0182$ A., and $\Delta\lambda = -0·021$ A., *i.e.* satellites Nos. +2 and −2.

5. Some considerations have been presented in support of the view that the components of the green line of mercury, for which $\Delta\lambda = +0·0182$ A., $0·0086$ A., $-0·0087$ A., $-0·021$ A., and zero, may originate in atoms of the element having respectively the weights 197, 198, 202, 204, and 200.

Satellites

−6ʹ, −5ʹ, −4ʹ, −2ʹ, +2ʹ, +3ʹ, +4ʹ.
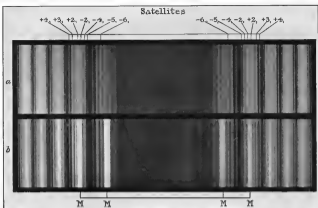
a

b

−6ʹ, −5ʹ, −4ʹ, +3ʹ, +2ʹ.

Unresᵈ

Fig. 3.

Satellites

+6 +5 +4 +3 +2 -2 -3 -4 -5 -6   -6 -5 -4 -3 -2 +2 +3 +4 +5 +6

a

b

M M   M M

Fig. 4.

d d d d   c b   b c   d d d d

a   d   d   a

a = Satellite − 6
b =   "   − 2
c =   "   + 2
d =   "   + 5

Fig. 5.

a   b   a   b

Fig. 7.   Fig. 8.